APPENDIX B

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The changes in dimensions provide a criterion for the degree of compacting and bonding of the fibre web which can be attained. The extent of this change in dimensions depends on a great number of factors of varying degrees of significance. The basic feature is that cross orientated fibre web increases in length and decreases in width when needled. With few exceptions, shortening will occur when coarse fibre is needled with fine needles [87], although with short fibres there may be an increase in width [87].

The use of coarser needles, lower fibre web mass, greater puncture depth and density, finer and shorter fibre, normally results in greater change in longitudinal dimension and vice versa. It should be noted that the needle fineness has the greatest effect, a point that has been repeatedly made [67, 71, 82, 86, 87, 96]. Higher crimp and delustering of the fibre causes a slight increase in the dimensional change lengthwise [87].

The fineness and length of the fibre has far less effect on dimensional change widthwise than lengthwise. The same applies for the fineness of the needle [87], the puncture depth being a more important factor [71].

In this respect, it is necessary to consider the interaction of the various influencing factors. Numerous experiments have shown the considerable interaction between, for example, puncture and titre of the fibre [87], between the mass of the fibre web and the fibre length [87], and between needle thickness and titre of the fibre [67, 71], on the longitudinal measurements, and between needle thickness and puncture depth, and puncture depth and puncture density, on the cross direction [67, 71, 97].

Figures 2.80–2.85 illustrates the respective bulking density (pressure = 2 $cN \cdot cm^{-2}$), the air permeability (test area = 20 cm^2, suppression = 2 mbar) and the maximum tensile load related to GSM and strip width for needled non-woven fabrics depending on important influencing factors. The figures given have been taken from a series of publications 67, 71, 86–88, 97, based on examination of cross orientated and partly lightly prestitched PA staple fibre web.

The thickness, GSM, bulking density and air permeability – which all provided information on the compactness of the needled fabric – are influenced by a number of factors. If finer needles, finer, longer and more tightly crimped fibres are used, if the GSM of the web and puncture depth and density are increased, the web density is greater and the air permeability is reduced (Figs. 2.80–2.85).

There is, however, an exception to this, for when finer fibres are needled with coarser needles, the web density does not increase (Fig. 2.80). There is neither an increase in web density nor a decrease in air permeability if the puncture density is increased (Fig. 2.85). In the latter case, there is interaction between the fineness of the needle and the puncture density.

As far as the strength of the needled non-woven fabric is concerned, the situation is similar to that for compactness, namely that finer needles, finer and longer fibre, greater GSM of the fibre web, and greater puncture depth and density, increase the strength (Figs. 2.80, 2.81, 2.83–2.85). It is also apparent, however, that once a certain 'critical' puncture depth or density has been reached, the rise in strength may be reversed and there may be a loss (Figs. 2.84 and 2.85).

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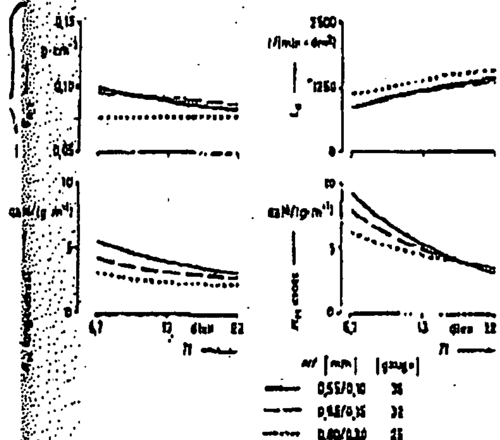

Fig. 2.80 – Web density $\rho_{B,2}$ and air permeability L_d, also maximum tensile strength R_H related to GSM and strip width for longitudinal and cross directions dependent on titre of fibre T_t for different needle gauges Nf (RB needles, embossed) [71]. Puncture depth E_t = 11 mm, puncture density E_{dNf} = 240 cm^{-2}; number of runs N_{pas} = 4; needle density N_d = 60 dm^{-1}; material feed in length L_f = 2.5 mm; fibre web, cross orientated, preneedled = 35 cm^{-2}; specified GSM $m_{A\,pv}$ = 350 g·m^{-2}; PA-6 staple, semi-dull, fibre length = 80 mm, same finish.

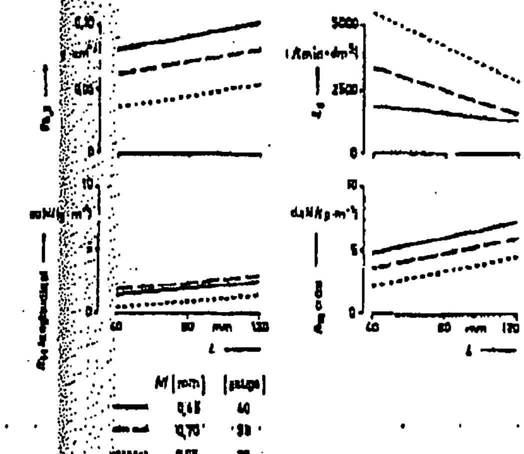

Fig. 2.81 – Web density $\rho_{B,2}$ and air permeability L_d, also maximum tensile strength R_H related to GSM and strip width for longitudinal and cross directions, dependent on fibre length L for different needle gauges Nf (RB needles, embossed) [87]. Puncture depth E_t = 13 mm, puncture density Ed_{pv} = 90 cm^{-2} fibre web, cross orientated, specified GSM $m_A \cdot P_v$ = 500 g·m^{-2}, PA-6 staple 11.3 dtex